SUPPLEMENT NO. 6

TIMBER CONNECTORS

DESIGN and LOAD DATA

MANUAL OF TIMBER CONNECTOR CONSTRUCTION

TIMBER ENGINEERING COMPANY

WASHINGTON, D. C.

A
NATIONAL LUMBER MANUFACTURERS ASSOCIATION
PUBLICATION

AIA FILE NO. B-19

TIMBER CONNECTORS—USES—TYPES

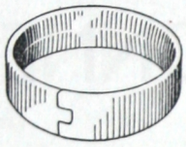
TECO connectors for timber construction are devices used in timber joints which give a high degree of efficiency to the connections and make possible the utilization of a higher proportion of the strength of the member outside the joint than is possible with most other types of fastenings.

Timber joint connectors were introduced into America by the National Committee on Wood Utilization of the U. S. Department of Commerce. Since then connectors have been widely used for many types of construction. Improvements in certain types and the development of new types of connectors have been accomplished so that the diversified requirements for connectors in timber construction are now quite completely met.

Timber joint connectors of several types have been extensively tested by the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture at Madison, Wisconsin.

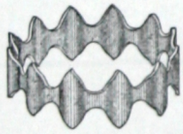
The designs and technical information presented in the following pages were prepared by J. E. Myer of the Timber Engineering Company, from the test data of the Forest Products Laboratory and from conferences with members of its staff, particularly John A. Newlin and J. A. Scholten, of the Division of Timber Mechanics. Acknowledgment is also made to various university and private laboratories.

TYPES OF TECO TIMBER CONNECTORS



SPLIT-RING

Manufactured from low carbon steel: Used between two timber faces for heavy construction and fits into pre-cut grooves in the timber faces. The tongue and groove "split" permits simultaneous ring bearing against the core wall and outer wall of the groove into which the ring is placed. The inside bevel and mill edge facilitates installation into and removal from its groove.



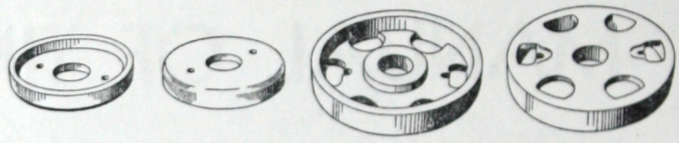
TOOTHED-RING

Manufactured from low carbon steel: Used between two timber faces for comparatively light construction and embedded into the contact faces of the joint members by means of pressure.

Male Female

CLAW-PLATES

Malleable iron connectors: Used as "units" either in pairs for timber-to-timber connections or singly in making timber-to-metal connections. The female plates are adapted to use when the connector must lie flush with the surface of the timber. Claw-plates are installed by forcing the teeth into the wood beyond the depth of the circular dap cut to receive the rim and plate portions.

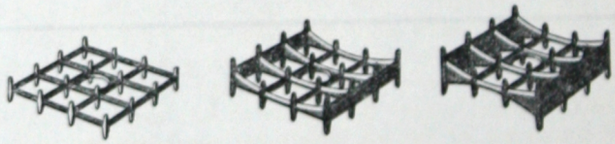


Front Back Front Back

Pressed-Steel Malleable Iron

SHEAR-PLATES

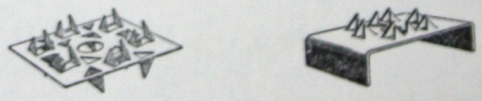
These plates when installed lie flush with the timber surface. They are used as "units" in pairs for timber-to-timber joints with two plates placed back to back, or singly in timber-to-metal joints with the plate placed with its back toward the metal. The plates fit into pre-cut grooves in the timber faces.



Flat Single Curve Double Curve

SPIKE-GRIDS

Manufactured from malleable cast iron: Used primarily in pier and trestle construction between either flat or curved surfaces. They are embedded into the wood surfaces by means of pressure.



Plain Flanged

CLAMPING-PLATES

Stamped from metal sheets: Used as railroad "tie spacers" between ties and guard timbers to keep the ties properly spaced, or where timbers overlap at right angles. The plain clamping plate with teeth on opposite faces is seated by means of a special block which protects the connector during the driving process. The flanged clamping-plate with teeth on one face only is driven into place with a maul or ram, the connector being protected from damage by a steel cover plate.

TIMBER CONNECTORS—FACTORS INFLUENCING ALLOWABLE LOADS

The allowable safe working loads for timber connectors presented in the tables are for standard use conditions.

STANDARD DESIGN LOADS

Standard Design Loads apply to most of the loading conditions under which all types of TECO connectors are used, where the dead loads are less than the live loads, and where the full live loads are applied for relatively short periods of time. They are 115 per cent of the basic values which were derived from test data by applying appropriate factors. For those connectors, namely, split-rings, claw-plates and shear-plates, which exhibited an initial straight line load-deformation ratio and a proportional limit, a factor either of 4.0 on maximum test loads or 1.8 on proportional limit loads was applied; the lower result being the basic value taken. Where the characteristics of test curves for connectors lacked a definite straight line load-deformation ratio, and where the proportional limit was not clearly indicated, such as for the toothed-rings, spike-grids and clamping-plates, a factor of 4.5 was applied to the maximum load. These factors are more conservative than those generally applied in foreign countries where connectors were developed and widely used. The basic values as determined above allow for a permanently applied full load, a condition not usually encountered in the use of timber connectors.

PERMISSIBLE LOAD INCREASES

Wood is able to support loads of short-time duration such as caused by wind, earthquake and impact, greatly in excess of permanently applied loads, hence appropriate increases in connector loads are allowed depending on whether the failure at ultimate joint load is of the wood, or a combination of wood and metal, or of the metal. Recommended load increases are given in the notes accompanying the table for each connector. Increases in connector loads in excess of those customarily allowed for wind and earthquake are justifiable for those types of structures where life hazard is not involved, where property damage would be slight in case of failure, where the ability to stay exactly in place is not important or where infrequent replacements are more economical than the expense involved in more conservative design.

LUMBER THICKNESS

Tabulated loads apply to connectors when used with lumber of the net thickness specified in the tables. The use of connectors in lumber thinner than the minimum given in the tables is not recommended.

CONDITION OF LUMBER

Tabulated loads apply to connectors used in lumber seasoned to approximately 15 per cent moisture content within 1/2" of the surface, which is the condition it will eventually reach in most parts of the United States. When installed in green or wet material which will remain wet a reduction in the tabulated loads is required. Where conditions are such that the lumber in which the connectors are installed will become seasoned to 15 per cent moisture content within a reasonable period of time, the full rated loads may be used with those connectors which fit into pre-cut grooves or daps; and reduced loads, depending on the moisture content, must be used with those connectors which are installed by being pressed into the wood. Notes for each connector give the degree of load reduction necessary.

LOADS FOR OTHER SPECIES

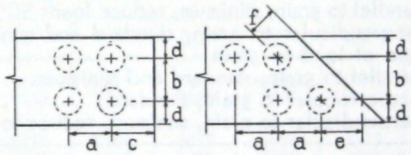
Loads for species not listed may be estimated by a comparison of their mechanical properties with those of the listed species or may be obtained on request from the Timber Engineering Company.

WORKING STRESSES FOR LUMBER AND TIMBER

For working stresses of lumber see Wood Structural Design Data, Supplement No. 1.

LOADS IN RELATION TO DISTANCES AND SPACINGS

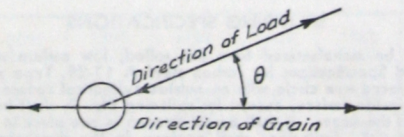
Standard Design Loads are for standard end and edge distances and spacings. Standard distances and minimum distances with load reduction factors are given in the tables accompanying the load tables. Loads for distances intermediate of standard and minimum are obtained by interpolation. These spacings and distances apply unless assemblies for specific use are tested and the results justify their modification. Distances and spacings of connectors are measured as shown in the accompanying diagrams.



a. Connector spacing parallel to grain
b. Connector spacing perpendicular to grain
c. End distance
d. Edge distance
e. Maintain end distance as minimum
f. Maintain edge distance

LOADS AT ANGLE TO GRAIN

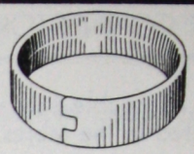
In general load capacities of connectors decrease as the angle of load to grain increases. The method of measuring angle of load to grain is shown by the following diagram.



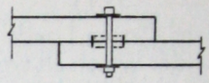
The angle θ used in determining the allowable loads on connectors, spacings between connectors, and edge and end distances, is that formed by the direction of grain in the member and the direction of the load transmitted to the member by the connector. When loads are axial in the members this angle is equal to the angle of intersection of the two members joined by the connector. When loads other than axial are superimposed on a member the direction of the resultant of all loads in the member is the direction of load used in determining angle to grain.

TIMBER CONNECTORS—SPLIT-RING DESIGN DATA

	1	2	3
SPLIT-RING, Order Number			
(All dimensions in inches)			
Inside diameter at center when closed	2-1/2	4	6
Thickness of metal			
Center	.163	.193	.245
Edge	.143	.173	.245
Depth	3/4	1	1-1/4
Inside diameter of groove for ring installation	2.56	4.08	6.12
Width of groove	.18	.21	.27
Depth of groove	.37	.50	.62
Shipping weight, per 100 rings, lbs.	30	76	196
LUMBER DIMENSIONS, minimum required for installation of rings			
Face width	3-5/8	5-1/2	7-1/2
Thickness, rings in one face only	1	1	1-5/8
Thickness, rings of same size, placed opposite in both faces	1-5/8	1-5/8	2
Thickness, with rings of different size, placed opposite in both faces	Use minimum for largest ring		
BOLT, diameter, minimum	1/2	3/4	3/4
Diameter, with rings of different size, placed opposite in both faces	Use minimum for largest ring		
BOLT HOLE, maximum diameter in timber	9/16	13/16	13/16
WASHERS, Standard			
Round, cast or malleable iron, diameter	2-1/8	3	3
Round, wrought iron (Minimum for use in simple structures)			
Diameter	1-3/8	2	.....
Thickness	3/32	5/32	.....
Square plate			
Length of side	2	3	3
Thickness	1/8	3/16	1/4
SPACING OF SPLIT-RINGS, center to center			
0°-30° angle of load to grain			
Spacing parallel to grain, standard, for full allowable load	6-3/4	9	12
Spacing parallel to grain, intermediate, reduce loads 25% except for one ring	5	6-7/8	9-1/2
Spacing parallel to grain, minimum, reduce loads 50% except for one ring	3-3/8	4-7/8	7
Spacing perpendicular to grain, standard and minimum	3-1/2	5-1/2	7-1/2
30°-90° angle of load to grain			
Spacing parallel to grain, standard and minimum	3-1/2	5-1/2	7-1/2
Spacing perpendicular to grain, standard	4-1/2	6-1/2	8-1/2
Spacing perpendicular to grain, minimum, reduce loads 15%	3-1/2	5-1/2	7-1/2
END DISTANCES, center of ring to end of piece			
Tension members, standard, for full allowable load	5-1/2	7	9
Tension members, minimum, reduce load 37.5%	2-3/4	3-1/2	4-1/2
With cross bolt between ring and end of piece, full load may be used with distances of	4	5-1/2	7-1/2
Compression members, standard	4	5-1/2	7-1/2
Compression members, minimum, reduce load 37.5%	2-1/2	3-1/4	4-1/4
EDGE DISTANCES, center of ring to edge of piece			
0°-30° angle of load to grain, standard and minimum	1-3/4	2-3/4	3-3/4
30°-90° angle of load to grain, standard, on compression side of ring	2-3/4	3-3/4	4-3/4
Minimum distance, reduce load 15%	1-3/4	2-3/4	3-3/4
30°-90° angle of load to grain, standard and minimum, opposite compression side of ring	1-3/4	2-3/4	3-3/4
PROJECTED AREA for portion of one ring within a member; square inches	1.10	2.25	4.16

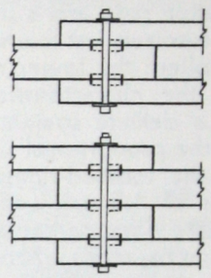


SPLIT-RING



SINGLE SPLIT-RING JOINT ASSEMBLY

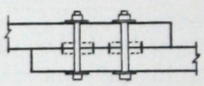
Split-ring in one face of each member



MULTIPLE SPLIT-RING JOINT ASSEMBLIES

Split-rings opposite in both faces of middle members; in one face of side members

(Single bolt and more than one ring)



MULTIPLE SPLIT-RING JOINT ASSEMBLY

Split-rings in one face of each member

(More than one bolt with split-ring on each bolt)

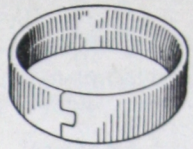
SPLIT-RING SPECIFICATIONS

Split-rings shall be manufactured from hot rolled, low carbon steel conforming to A.S.T.M. Standard Specifications for carbon steel A 17-29, Type A, Grade 1. Each ring shall form a closed true circle with an outside cylindrical surface parallel to the axis of the ring. The inside surface, except for split-ring No. 3, shall be beveled from the median line toward the edges. It shall be cut through in one place in its circumference to form a tongue and slot. Split-rings shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to split-rings used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface or in green lumber which will reach this condition in the structure within a reasonable period of time. If used in green lumber which will stay wet, use 67 per cent of the tabulated loads.

TIMBER CONNECTORS—SPLIT-RINGS—SAFE LOADS


SPLIT-RING

SINGLE SPLIT-RING LOADS

The loads given are for a two-member joint assembly with one split-ring, a bolt, two washers and a nut.

MULTIPLE SPLIT-RING LOADS

For a joint assembly in which more than one split-ring of the same or of different sizes are used in the contact faces concentric with the same bolt axis or in which more than one bolt is used with split-rings on each bolt, the safe load is the sum of the loads given for each ring used.

CONCENTRIC PLACEMENT BETWEEN SAME TIMBER SURFACES

When grooves for two sizes of split rings are cut, concentric in the same timber surface, rings shall be installed in both grooves and the allowable load shall be equal to the tabulated load for the larger ring only.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both,-the safe loads on split-rings may be taken as 130 per cent of the Standard Design Loads provided the resulting size or number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using the Standard Design Loads, the load on a split-ring due to a force producing impact shall be taken as 57.5 per cent of the sum of the force as a static load and the load due to its impact, but shall not be taken as less than the load caused by the force acting as a permanent static load; i. e., impact up to 74 per cent of the force producing impact may be neglected.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 4. Loads for end and edge distances and spacings intermediate of standard and minimum may be determined by interpolation.

LOAD AT ANGLE TO GRAIN

Loads at angles to grain intermediate of those in the table may be determined by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average total deformations in inches for split-ring joints from zero load to Standard Design Loads are as follows:

Split-Ring Number	Ring Diameter inches	Load Applied Parallel to grain inches	Load Applied Perpendicular to grain inches
1	2-1/2	.040	.050
2	4	.045	.055
3	6	.050†	.060†

†Estimated

STANDARD DESIGN LOADS FOR ONE SPLIT-RING AND BOLT IN SINGLE SHEAR

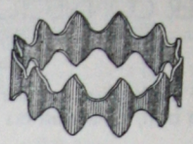
Species	SPLIT-RING Number	SPLIT-RING diameter (inches)	BOLT diameter (inches)	Lumber thickness (net) for Connectors used: In one face only	Lumber thickness (net) for Connectors used: Opposite in two faces	Allowable LOAD in pounds per CONNECTOR and BOLT at angle of load to grain of: 0°	15°	30°	45°	60°	75°	90°
GROUP A Dense structural grades of Douglas Fir, Southern Pine	1	2½	½	1" and thicker	1-5/8"	2750	2618	2487	2355	2223	2092	1960
					2" and thicker	3300	3142	2983	2825	2667	2508	2350
	2	4	¾*	1"		4270	4058	3847	3635	3423	3212	3000
					1-5/8"	4500	4277	4053	3830	3607	3383	3160
					2"	5170	4914	4657	4401	4144	3887	3630
				1-5/8" and thicker	2-5/8"	6300	5985	5670	5355	5040	4720	4410
					3" and thicker	6400	6080	5760	5440	5120	4800	4480
	3	6	¾		2"	7000	6533	6067	5600	5133	4667	4200
					2-5/8"	8345	7789	7233	6678	6122	5566	5010
				1-5/8"	3"	9155	8544	7933	7323	6712	6101	5490
				2" and thicker	3-5/8" and thicker	10500	9800	9100	8400	7700	7000	6300
GROUP B Non-dense structural grades of Douglas Fir, Southern Pine; structural grades of Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak	1	2½	½	1" and thicker	1-5/8"	2375	2258	2140	2023	1905	1788	1670
					2" and thicker	2850	2708	2567	2425	2283	2142	2000
	2	4	¾*	1"		3660	3478	3297	3115	2933	2752	2570
					1-5/8"	3850	3658	3467	3275	3084	2892	2700
					2"	4430	4207	3983	3760	3537	3313	3090
				1-5/8" and thicker	2-5/8"	5400	5130	4860	4590	4320	4050	3780
					3" and thicker	5500	5225	4950	4675	4400	4125	3850
	3	6	¾		2"	6000	5600	5200	4800	4400	4000	3600
					2-5/8"	7155	6678	6200	5723	5245	4768	4290
				1-5/8"	3"	7845	7323	6800	6278	5755	5233	4710
				2" and thicker	3-5/8" and thicker	9000	8400	7800	7200	6600	6000	5400
GROUP C Structural grades of Cypress, Redwood	1	2½	½	1" and thicker	1-5/8"	2000	1896	1792	1688	1583	1479	1375
					2" and thicker	2400	2275	2150	2025	1900	1775	1650
	2	4	¾*	1"		3070	2913	2757	2600	2443	2287	2130
					1-5/8"	3230	3065	2900	2735	2570	2405	2240
					2"	3710	3522	3333	3145	2957	2768	2580
				1-5/8" and thicker	2-5/8"	4500	4275	4050	3825	3600	3375	3150
					3" and thicker	4580	4350	4120	3890	3660	3430	3200
	3	6	¾		2"	5000	4667	4333	4000	3667	3333	3000
					2-5/8"	5960	5563	5165	4768	4370	3973	3575
				1-5/8"	3"	6540	6104	5668	5233	4797	4361	3925
				2" and thicker	3-5/8" and thicker	7500	7000	6500	6000	5500	5000	4500

*Loads for the No. 2, 4" split-ring may be increased 3-1/2% and 7% in lumber 2-5/8" thick and 5-1/2% and 10% in lumber 3" thick for 7/8" and 1" bolts, respectively, when used in place of the 3/4" bolt; also, loads for 4" split-rings when used with 7/8" and 1" bolts in lumber 3-5/8" thick or thicker may be taken as 112% and 119% respectively of the tabulated loads for the connector with 3/4" bolt in 3" material.

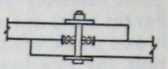
Basic values for split-rings, from which Standard Design Loads for the different thicknesses of lumber were derived, for Group B species parallel to the grain are 2480 lbs., 4785 lbs. and 7820 lbs., and perpendicular to the grain are 1740 lbs., 3350 lbs. and 4700 lbs. for the Nos. 1, 2 and 3 split-rings respectively. Values for Group A species are approximately 16 per cent greater and values for Group C species are approximately 16 per cent less than those for Group B species. For wind loads basic values may be increased 50 per cent and impact up to 100 per cent of the force producing impact may be neglected.

TIMBER CONNECTORS—TOOTHED-RINGS DESIGN DATA

TOOTHED-RING, Order Number	1	2	3	4
(All dimensions in inches)				
Diameter	2	2-5/8	3-3/8	4
Thickness of metal	.061	.061	.061	.061
Depth	.94	.94	.94	.94
Depth of fillet, minimum	.25	.25	.25	.25
Shipping weight, per 100 rings, lbs.	9.0	12.0	15.0	18.0
LUMBER DIMENSIONS, minimum required for installation of rings				
Face width, standard and minimum	3	3-5/8	4-5/8	5-1/2
Thickness, rings in one face only	1	1	1	1
Thickness, rings opposite in both faces	1-5/8	1-5/8	1-5/8	1-5/8
BOLT, diameter, minimum	1/2	5/8	3/4	3/4
Diameter for rings of different size placed on same bolt	Use minimum for larger ring			
BOLT HOLE, maximum diameter in timber	9/16	11/16	13/16	13/16
WASHERS, minimum				
Round, cast or malleable iron, diameter	2	2-5/8	3	3-1/2
Square plate				
Length of side	2	2-1/2	3	3-1/2
Thickness	3/16	1/4	1/4	3/8
SPACING OF TOOTHED-RINGS, center to center				
0°-30° angle of load to grain				
Spacing parallel to grain, standard, for full allowable load	3-1/2	4-1/2	5-3/4	7
Spacing parallel to grain, intermediate, reduce loads 25% except for one ring	3-1/4	4-1/8	5-1/8	6
Spacing parallel to grain, minimum, reduce loads 50% except for one ring	3	3-5/8	4-3/8	5
Spacing perpendicular to grain, standard and minimum	2-1/2	3-1/8	3-7/8	4-1/2
30°-90° angle of load to grain				
Spacing parallel to grain	2-1/2	3-1/8	3-7/8	4-1/2
Spacing perpendicular to grain	3	3-1/2	4-1/2	5-1/2
END DISTANCES, center of ring to end of piece				
Tension members, standard, for full allowable load	3-1/2	4-1/2	5-3/4	7
Tension members, minimum, reduce load 33%	2	2-5/8	3-3/8	4
With cross bolt between ring and end of piece, the full load may be used with distances of	2	2-5/8	3-3/8	4
Compression members, standard and minimum	2	2-5/8	3-3/8	4
EDGE DISTANCES, center of ring to edge of piece				
0°-30° angle of load to grain	1-1/2	1-3/4	2-1/4	2-3/4
30°-90° angle of load to grain, standard	2	2-1/2	3	3-1/2
30°-90° angle of load to grain, minimum, reduce load 15%	1-1/2	1-3/4	2-1/4	2-3/4
PROJECTED AREA for portion of one ring within member, square inches	.94	1.23	1.59	1.88

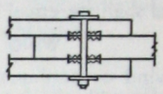


TOOTHED-RING



SINGLE TOOTHED-RING JOINT ASSEMBLY

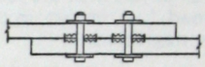
Toothed-ring in one face of each member



MULTIPLE TOOTHED-RING JOINT ASSEMBLY

Toothed-rings opposite in both faces of middle members; in one face of side members

(Single bolt and more than one ring)



MULTIPLE TOOTHED-RING JOINT ASSEMBLY

Toothed-rings in one face of each member

(More than one bolt with ring on each bolt)

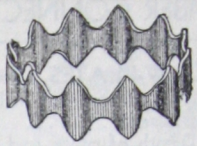
TOOTHED-RING SPECIFICATIONS

Toothed-ring timber connectors shall be stamped cold from U. S. Standard 16 gage hot rolled sheet steel conforming to A.S.T.M. Standard Specifications for carbon steel A 17-29, Type A, Grade 1, and shall be bent cold to form a circular, corrugated, sharp-toothed band and welded into a solid ring. The teeth on each ring shall be on a true circle and shall be parallel to the axis of the ring. The central band shall be welded to fully develop the strength of the band. Toothed-rings shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to toothed-rings used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface. Loads for toothed-rings in green lumber (24 per cent or more moisture content) should not exceed 60 per cent of those shown; for intermediate moisture contents between 24 per cent and 15 per cent, interpolate according to the percentage of moisture content of the timber surface.

TIMBER CONNECTORS—TOOTHED-RINGS—SAFE LOADS


TOOTHED-RING

SINGLE TOOTHED-RING LOADS

The loads given are for a two-member joint assembly with one toothed-ring, a bolt, two washers and a nut.

MULTIPLE TOOTHED-RING LOADS

For a joint assembly in which more than one toothed ring of the same or of different sizes are used in the contact faces concentric with the same bolt axis or in which more than one bolt is used with toothed-rings on each bolt, the safe load is the sum of the loads given for each ring used.

CONCENTRIC PLACEMENT BETWEEN SAME TIMBER SURFACE

Two toothed-rings in combination of the sizes Nos. 1 and 3, Nos. 1 and 4, or Nos. 2 and 4 may be placed concentrically to the same bolt between the same timber surfaces. These combinations result in a total load value equal to the tabulated load for the larger ring plus 25 per cent of the tabulated load for the smaller ring.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on toothed-rings may be taken as 116 per cent of the Standard Design Loads, provided the resulting size and number of connectors are not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a toothed-ring due to a force producing impact shall be taken as 115% of the sum of the force as a static load and the load due to its impact.

LOADS AT ANGLE TO GRAIN

Loads at angle to grain intermediate of those given in the table may be determined by interpolation.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 6. Loads for end and edge distances and spacings intermediate of standard and minimum may be obtained by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average deformations in inches for toothed-ring joints from zero load to Standard Design Loads are as follows:

Toothed-Ring Number	Ring Diameter inches	Load Applied Parallel to grain inches	Load Applied Perpendicular to grain inches
1	2	.004	.006
2	2-5/8	.006†	.008†
3	3-3/8	.008	.010†
4	4	.010	.012†

† Estimated.

STANDARD DESIGN LOADS FOR ONE TOOTHED-RING AND BOLT IN SINGLE SHEAR

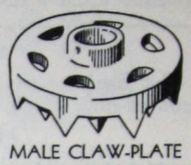
Species	TOOTHED-RING Number	TOOTHED-RING diameter (inches)	BOLT diameter (inches)	Lumber thickness (net) for Connectors used: In one face only	Lumber thickness (net) for Connectors used: Opposite in two faces	Allowable LOAD in pounds per CONNECTOR and BOLT at angle of load to grain of: 0°	7½°	15°	22½°	30°	37½°	45°-90°
GROUP A — Dense structural grades of Douglas Fir, Southern Pine	1	2	½★	1" and thicker	1-5/8"	1265	1213	1160	1108	1055	1003	950
					2" and thicker	1390	1332	1273	1215	1157	1098	1040
	2	2⅝	⅝	1"		1580	1514	1448	1382	1317	1251	1185
					1-5/8"	1900	1821	1742	1663	1583	1504	1425
				1-5/8" and thicker	2"	2100	2013	1925	1838	1750	1663	1575
					2-1/2" and thicker	2370	2273	2175	2078	1980	1883	1785
	3	3⅜	¾	1"		2225	2133	2040	1948	1855	1763	1670
					1-5/8"	2470	2367	2263	2160	2057	1953	1850
					2"	2705	2593	2480	2368	2255	2143	2030
				1-5/8" and thicker	2-5/8"	3100	2970	2840	2710	2580	2450	2320
					3" and thicker	3335	3196	3057	2918	2778	2639	2500
	4	4	¾	1"		2575	2468	2360	2253	2145	2038	1930
					1-5/8"	2970	2847	2723	2600	2477	2353	2230
					2"	3215	3081	2947	2813	2678	2544	2410
				1-5/8" and thicker	2-5/8"	3620	3469	3317	3165	3013	2862	2710
					3" and thicker	3860	3699	3537	3375	3213	3052	2890
GROUP B — Non-dense structural grades of Douglas Fir, Southern Pine; structural grades of Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak	1	2	½★	1" and thicker	1-5/8"	1150	1103	1055	1008	960	913	865
					2" and thicker	1265	1213	1160	1108	1055	1003	950
	2	2⅝	⅝	1"		1435	1375	1315	1255	1195	1135	1075
					1-5/8"	1725	1654	1582	1510	1438	1367	1295
				1-5/8" and thicker	2"	1910	1830	1750	1670	1590	1510	1430
					2-1/2" and thicker	2155	2066	1977	1888	1798	1709	1620
	3	3⅜	¾	1"		2020	1936	1852	1768	1683	1599	1515
					1-5/8"	2245	2151	2057	1963	1868	1774	1690
					2"	2460	2358	2255	2153	2050	1948	1845
				1-5/8" and thicker	2-5/8"	2815	2698	2580	2463	2345	2228	2110
					3" and thicker	3030	2904	2777	2650	2523	2397	2270
	4	4	¾	1"		2340	2243	2145	2048	1950	1853	1755
					1-5/8"	2700	2588	2475	2363	2250	2138	2025
					2"	2920	2799	2677	2555	2433	2312	2190
				1-5/8" and thicker	2-5/8"	3290	3154	3017	2880	2743	2607	2470
					3" and thicker	3510	3364	3217	3070	2923	2777	2630
GROUP C — Structural grades of Cypress, Redwood	1	2	½★	1" and thicker	1-5/8"	1035	992	948	905	862	818	775
					2" and thicker	1140	1092	1043	995	947	898	850
	2	2⅝	⅝	1"		1294	1240	1186	1132	1078	1024	970
					1-5/8"	1555	1490	1425	1360	1295	1230	1165
				1-5/8" and thicker	2"	1720	1649	1577	1505	1433	1362	1290
					2-1/2" and thicker	1940	1859	1778	1697	1617	1536	1455
	3	3⅜	¾	1"		1815	1739	1663	1587	1512	1436	1360
					1-5/8"	2020	1936	1852	1768	1683	1599	1515
					2"	2210	2119	2027	1935	1843	1752	1660
				1-5/8" and thicker	2-5/8"	2530	2425	2320	2215	2110	2005	1900
					3" and thicker	2725	2612	2498	2385	2272	2158	2045
	4	4	¾	1"		2105	2018	1930	1843	1755	1668	1580
					1-5/8"	2430	2329	2227	2125	2023	1922	1820
					2"	2630	2520	2410	2300	2190	2080	1970
				1-5/8" and thicker	2-5/8"	2960	2837	2713	2590	2467	2343	2220
					3" and thicker	3160	3029	2897	2765	2633	2502	2370

★ Increase loads 20% when ⅝" bolt is used in place of ½" bolt.

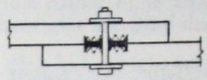
Basic values for toothed-rings, from which Standard Design Loads for the different thicknesses of lumber were derived, for Group B species parallel to the grain are 1100 lbs., 1875 lbs., 2630 lbs. and 3055 lbs., and perpendicular to the grain are 825 lbs., 1405 lbs. 1970 lbs., and 2290 lbs. for the Nos. 1, 2, 3 and 4 toothed-rings respectively. Values for Group A species are 10 per cent greater and values for Group C species are 10 per cent less than those for Group B species. For wind loads basic values may be increased 33%

TIMBER CONNECTORS—CLAW-PLATE DESIGN DATA

CLAW-PLATES, Order Number	1 Male	1A Female	2 Male	2A Female	3 Male	3A Female
(All dimensions in inches)						
Diameter	2-5/8	2-5/8	3-1/8	3-1/8	4	4
Depth of plate and teeth	.75	.75	.75	.75	.75	.75
Depth of outside hub	.37	.....	.37	.....	.37	.....
Diameter of outside hub	.87	.....	.87	.....	1.22	.....
Diameter of central hole	.53	.90	.53	.90	.78	1.25★
Shipping weight, per 100 claw-plates, lbs.	58	40	70	59	93	80
DIMENSIONS OF CIRCULAR DAP						
(A)	2.64	2.64	3.16	3.16	4.07	4.07
(B)	1.12	1.12	1.14	1.14	1.55	1.55
(C)	9/16	15/16	9/16	15/16	13/16	1-1/4
(D)	.52	.52	.76	.76	1.01	1.01
(E)	.25	.25	.25	.25	.25	.25
(F)	.38	.38	.38	.38	.38	.38
(G)	.22	.22	.22	.22	.28	.28
(H)	.42	.42	.42	.42	.45	.45
LUMBER DIMENSIONS, minimum required for installation of plates						
Face width	3-5/8	3-5/8	4-5/8	4-5/8	5-1/2	5-1/2
Thickness, plates in one face only	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
Thickness, plates opposite in both faces	2	2	2	2	2	2
STEEL STRAPS OR SHAPES used in combination with claw-plates						
Standard thickness	3/8	3/8	3/8	3/8	3/8	3/8
Minimum, (washers must be used to take up difference in hub depth of male claw-plate)	1/4	1/4	1/4	1/4	1/4	1/4
HOLE, diameter in straps or plates	29/32	29/32	29/32	29/32	1-1/4	1-9/32
BOLT, diameter when male plates are used singly or male & female are used in combination	1/2	.....	1/2	.....	3/4	.....
Diameter when female plates are used without male plates	.....	7/8	.....	7/8	.....	1-1/4
BOLT HOLE, diameter in timber when male plates or a combination of male & female plates are used	9/16	.....	9/16	.....	13/16	.....
Diameter when female plates are used without male plates	.....	15/16	.....	15/16	.....	1-5/16
WASHERS, minimum						
Timber-to-Timber Connections						
Round, cast or malleable iron, diameter	2-1/8	3-1/2	2-1/8	3-1/2	3	4-3/8
Square plate: Length of side	2	3	2	3	3	4
Thickness	3/16	1/4	3/16	1/4	3/8	3/8
Timber-to-Steel Connections						
Round wrought iron: Diameter	2	2	2	2	4	4
Thickness	5/32	5/32	5/32	5/32	11/64	11/64
SPACING OF CLAW-PLATES, center to center						
0°-30° angle of load to grain						
Spacing parallel to grain, standard	6-3/4	6-3/4	7-3/4	7-3/4	9	9
Spacing parallel to grain, intermediate, reduce loads 25% except for one ring	5	5	6	6	6-7/8	6-7/8
Spacing parallel to grain, minimum, reduce loads 50% except for one ring	3-3/8	3-3/8	4	4	4-7/8	4-7/8
Spacing perpendicular to grain, standard and minimum	3 1/2	3-1/2	4-1/4	4-1/4	5-1/2	5-1/2
30°-90° angle of load to grain						
Spacing parallel to grain, standard and minimum	3-1/2	3-1/2	4-1/4	4-1/4	5 1/2	5-1/2
Spacing perpendicular to grain, standard	4-1/2	4-1/2	5-1/4	5-1/4	6-1/2	6-1/2
Spacing perpendicular to grain, minimum, reduce loads 15%	3-1/2	3-1/2	4-1/4	4-1/4	5-1/2	5-1/2
END DISTANCES, center of plate to end of piece						
Tension members, standard	5-1/2	5-1/2	6	6	7	7
Tension members, minimum, reduce load 37.5%	2-3/4	2-3/4	3	3	3-1/2	3-1/2
With cross bolt between claw-plate and end of piece, full load may be used with distances of	4	4	4-1/2	4-1/2	5-1/2	5-1/2
Compression members, standard	4	4	4-1/2	4-1/2	5-1/2	5-1/2
Compression members, minimum, reduce load 37.5%	3	3	3-1/2	3-1/2	4-1/2	4-1/2
EDGE DISTANCES, center of plate to edge of piece						
0°-30° angle of load to grain, standard and minimum	1-3/4	1-3/4	2-1/8	2-1/8	2-3/4	2-3/4
30°-90° angle of load to grain, standard on compression side of plate	2-3/4	2-3/4	3-1/8	3-1/8	3-3/4	3-3/4
Minimum distance, reduce load 15%	1-3/4	1-3/4	2-1/8	2-1/8	2-3/4	2-3/4
30°-90° angle of load to grain, standard and minimum, opposite compression side of plate	1-3/4	1-3/4	2-1/8	2-1/8	2-3/4	2-3/4
PROJECTED AREA for one claw-plate only, Square inches	1.97	1.97	2.34	2.34	3.00	3.00



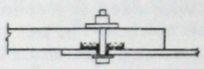
MALE CLAW-PLATE



WOOD-TO-WOOD JOINT

Claw-plate in one face of each member

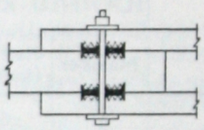
(One unit—one claw-plate with and one without hub)



WOOD-TO-STEEL JOINT

Claw-plate in one face of wood member

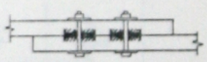
(One unit—one claw-plate only with hub)



MULTIPLE CLAW-PLATE JOINT

Claw-plates opposite in both faces of middle members; in one face of side members

(Two units of claw-plates)



MULTIPLE CLAW-PLATE UNIT JOINT

Claw-plates in one face of each member

(More than one bolt with claw-plates on each bolt)

CLAW-PLATE SPECIFICATIONS

Claw-plate timber connectors shall be malleable iron castings, manufactured according to A.S.T.M. Standard Specifications A 47-33, Grade 35018. Each claw-plate shall consist of a perforated circular flanged plate with three-sided teeth arranged about the perimeter of one face. The male plate shall have integral cylindrical hubs on both faces concentric to a bolt hole through the center of the plate. The female plate shall be flat on the side opposite the teeth but shall have an integral cylindrical hub concentric to the central bolt hole and on the face with the teeth. Claw-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to claw-plates used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface or in green material which will reach this condition in the structure within a reasonable period of time. If used in green material which will stay wet, use 67 per cent of the tabulated loads.

★ When used without male plate and with 1-1/4" bolt, ream hole to 1-5/16".

TIMBER CONNECTORS—CLAW-PLATES—SAFE LOADS

FEMALE CLAW-PLATE

CLAW-PLATE WORKING LOADS

Loads given are for a two member joint assembly with a single connector unit (a unit may consist of two plates, male and female in combination, or of two female plates used back to back in the contact faces of a timber-to-timber joint, or of one male or one female plate used in conjunction with a steel strap or shape in a timber-to-metal joint) used with a bolt, two washers and a nut.

MULTIPLE CLAW-PLATE LOADS

For a joint assembly in which more than one claw-plate unit is used with the same bolt or in which more than one bolt is used with claw-plates on each bolt, the safe load is the sum of the loads for all the units.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on claw-plates may be taken as 116% of the Standard Design Loads parallel to the grain and as 130% of the Standard Design Loads perpendicular to grain with loads at intermediate angles to the grain obtained by interpolation, provided the resulting size and number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a claw-plate unit due to a force producing impact shall be taken as 115% of the sum of the force as a static load and the load due to its impact.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 8. Loads for end and edge distances and spacings intermediate of standard and minimum may be determined by interpolation.

LOAD AT ANGLE TO GRAIN

Loads at angles to grain intermediate of those in the table may be determined by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average deformations in inches for claw-plate joints from zero load to Standard Design Loads are as follows:

Claw-plate Number	Plate Diameter inches	Load Applied Parallel to grain inches	Load Applied Perpendicular to grain inches
1 and 1A	2-5/8	.015	.023
2 and 2A	3-1/8	.038	.045
3 and 3A	4	.038	.045

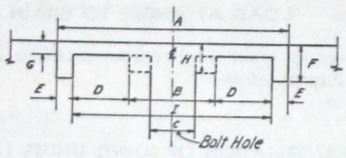
STANDARD DESIGN LOADS FOR ONE CLAW-PLATE UNIT AND BOLT IN SINGLE SHEAR

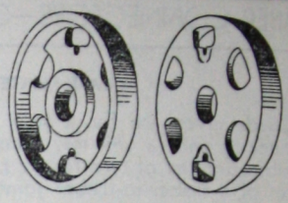
Species	CLAW-PLATE Number	CLAW-PLATE diameter (inches)	BOLT diameter (inches)	Lumber thickness (net) for Connectors used: In one face only	Lumber thickness (net) for Connectors used: Opposite in two faces	Allowable LOAD in pounds per CONNECTOR UNIT and BOLT at angle of load to grain of: 0°	15°	30°	45°	60°	75°	90°
GROUP A Dense structural grades of **Douglas Fir, Southern Pine**	1	2 5/8	1/2	1-5/8" and thicker...	2"...	2400	2302	2203	2105	2007	1908	1810
					2-5/8" and thicker..	3600	3453	3307	3160	3013	2867	2720
	2	3 1/8	1/2	1-5/8" and thicker...	2"...	3130	3003	2877	2750	2623	2497	2370
					2-5/8"...	4110	3944	3778	3612	3447	3281	3115
					3" and thicker.....	4700	4510	4320	4130	3940	3750	3560
	3	4	3/4	1-5/8"...	2"...	3990	3833	3677	3520	3363	3207	3050
					2-5/8"...	4820	4631	4441	4252	4063	3874	3685
					3"...	5320	5111	4903	4693	4483	4274	4065
				1-3/4" and thicker...	3-5/8" and thicker..	5980	5745	5510	5275	5040	4805	4570
GROUP B Non-dense structural grades of **Douglas Fir, Southern Pine;** structural grades of **Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak**	1	2 5/8	1/2	1-5/8" and thicker...	2"...	2090	2003	1917	1830	1743	1657	1570
					2-5/8" and thicker..	3130	3002	2873	2745	2617	2483	2360
	2	3 1/8	1/2	1-5/8" and thicker...	2"...	2730	2618	2507	2395	2283	2172	2060
					2-5/8"...	3580	3433	3288	3142	2997	2851	2705
					3" and thicker.....	4090	3923	3757	3590	3423	3257	3070
	3	4	3/4	1-5/8"...	2"...	3470	3333	3197	3060	2923	2787	2650
					2-5/8"...	4190	4025	3860	3695	3530	3365	3200
					3"...	4620	4438	4257	4075	3893	3712	3530
				1-3/4" and thicker...	3-5/8" and thicker..	5200	4995	4790	4585	4380	4175	3970
GROUP C Structural grades of **Cypress, Redwood**	1	2 5/8	1/2	1-5/8" and thicker...	2"...	1770	1710	1650	1590	1530	1470	1410
					2-5/8" and thicker..	2660	2568	2477	2385	2293	2202	2110
	2	3 1/8	1/2	1-5/8" and thicker...	2"...	2310	2217	2123	2030	1937	1843	1750
					2-5/8"...	3035	2913	2790	2668	2545	2423	2300
					3" and thicker.....	3470	3330	3190	3050	2910	2770	2630
	3	4	3/4	1-5/8"...	2"...	2950	2833	2717	2600	2483	2367	2250
					2-5/8"...	3560	3419	3278	3137	2997	2856	2715
					3"...	3930	3775	3620	3465	3310	3155	3000
				1-3/4" and thicker...	3-5/8" and thicker..	4420	4245	4070	3895	3720	3545	3370

Basic values for claw-plates, from which Standard Design Loads for the different thicknesses of lumber were derived, for Group B species parallel to the grain are 2730 lbs., 3560 lbs. and 4520 lbs., and perpendicular to the grain are 2050 lbs., 2670 lbs. and 3450 lbs. for the Nos. 1 and 1A, 2 and 2A, and 3 and 3A claw-plates respectively. Values for Group A species are 15 per cent greater and values for Group C species are 15 per cent less than those for Group B species. For wind loads basic values may be increased 33-1/3 per cent.

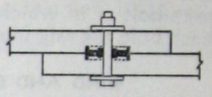
TIMBER CONNECTORS—SHEAR-PLATE DESIGN DATA

SHEAR-PLATES, Order Number	1	2	2-A★
Material	Pressed Steel	Malleable Iron	Malleable Iron
(All dimensions in inches)			
Diameter of plate	2-5/8"	4"	4"
Diameter of bolt hole	.81	.81	.94
Thickness of plate	.169	.20	.20
Depth of flange	.375	.62	.62
Shipping weight, per 100 plates, lbs.	40	100	100
DIMENSIONS OF CIRCULAR DAP			
(A)	2.63	4.03	4.03
(B)	.....	1.55	1.55
(C)	13/16	13/16	15/16
(D)	.....	.97	.97
(E)	.19	.27	.27
(F)	.45	.64	.64
(G)	.25	.22	.22
(H)	.....	.50	.50
(I)	2.25	3.49	3.49
LUMBER DIMENSIONS, minimum required for installation of plates			
Face width	3-5/8	5-1/2	5-1/2
Thickness, plates in one face only	1	1-5/8	1-5/8
Thickness, plates opposite in both faces	1-5/8	1-3/4	1-3/4
STEEL STRAPS OR SHAPES used in combination with shear-plates			
Minimum thickness, plates on one face of straps or shapes	1/4	3/8	3/8
Minimum thickness, plates opposite on both faces of straps or shapes	1/2	3/4	3/4
Hole diameter in straps or shapes for bolts	13/16	13/16	15/16
BOLT, diameter	3/4	3/4	7/8
BOLT HOLE, diameter in timber	13/16	13/16	15/16
WASHERS, standard			
Round, cast or malleable iron, diameter	3	3	3-1/2
Round, wrought iron (minimum, for use in simple structures):			
Diameter	2	2	2-1/4
Thickness	5/32	5/32	11/64
Square plate:			
Length of side	3	3	3
Thickness	1/4	1/4	1/4
SPACING OF SHEAR-PLATES, center to center			
0°-30° angle of load to grain			
Spacing parallel to grain, standard for full allowable load	6-3/4	9	9
Spacing parallel to grain, intermediate, reduce loads 25% except for one ring	5	6-7/8	6-7/8
Spacing parallel to grain, minimum, reduce loads 50% except for one ring.	3-3/8	4-7/8	4-7/8
Spacing perpendicular to grain, standard and minimum	3-1/2	5-1/2	5-1/2
30°-90° angle of load to grain			
Spacing parallel to grain, standard and minimum	3-1/2	5-1/2	5-1/2
Spacing perpendicular to grain, standard	4-1/2	6-1/2	6-1/2
Spacing perpendicular to grain, minimum, reduce loads 15%	3-1/2	5-1/2	5-1/2
END DISTANCES, center of plate to end of piece			
Tension members, standard	5-1/2	7	7
Tension members, minimum, reduce load 37.5%	2-3/4	3-1/2	3-1/2
With cross bolt between plate and end of piece, full load may be used with distances of	4	5-1/2	5-1/2
Compression members, standard	4	5-1/2	5-1/2
Compression members, minimum, reduce load 37.5%	2-1/2	3-1/4	3-1/4
EDGE DISTANCES, center of plate to edge of piece			
0°-30° angle of load to grain, standard and minimum	1-3/4	2-3/4	2-3/4
30°-90° angle of load to grain, standard on compression side of plate	2-3/4	3-3/4	3-3/4
Minimum distance, reduce load 15%	1-3/4	2-3/4	2-3/4
30°-90° angle of load to grain, standard and minimum, opposite compression side of plate	1-3/4	2-3/4	2-3/4
PROJECTED AREA for one shear-plate, square inches	0.98	2.48	2.48





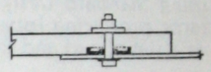
MALLEABLE IRON SHEAR-PLATES



WOOD-TO-WOOD JOINT

Shear-plate in one face of each member

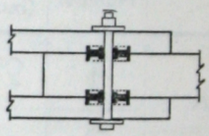
(One unit, two shear-plates back-to-back)



WOOD-TO-STEEL JOINT

Shear-plate in one face of wood member

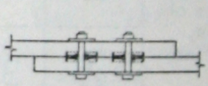
(One unit, one shear-plate only)



MULTIPLE SHEAR-PLATE JOINT

Shear-plates opposite in both faces of middle members; in one face of side member

(Two units of shear-plates)



MULTIPLE SHEAR-PLATE UNIT JOINT

(More than one bolt with shear-plates on each bolt)

SHEAR-PLATE SPECIFICATIONS

Pressed Steel Type—Pressed steel shear-plates shall be manufactured from mild steel conforming to A.S.T.M. Standard Specifications for carbon steel A 17-29, Type A, Grade 1. Each plate shall be a true circle with a flange around the edge, extending at right angles to the face of the plate and extending from one face only, the plate portion having a central bolt hole and two small perforations on opposite sides of the hole and midway from the center and circumference. Shear-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

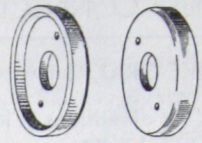
Malleable Iron Type—Malleable iron shear-plates shall be manufactured according to A.S.T.M. Standard Specifications A 47-33, Grade 35018, for malleable iron castings. Each casting shall consist of a perforated round plate with a flange around the edge extending at right angles to the face of the plate and projecting from one face only, the plate portion having a central bolt hole reamed to size with an integral hub concentric to the bolt hole and extending from the same face as the flange. Shear-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to shear-plates used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface or in green lumber which will reach this condition in the structure within a reasonable period of time. If used in green lumber which will stay wet, use 67 per cent of the tabulated loads.

★ Shear-plate No. 2-A is identical with No. 2 except for size of bolt hole.

TIMBER CONNECTORS—SHEAR-PLATES—SAFE LOADS



PRESSED STEEL SHEAR-PLATES

SHEAR-PLATE WORKING LOADS

The loads given are for a two member joint assembly with a single connector unit (a unit may consist either of two plates used back-to-back in the contact faces of a timber-to-timber joint or of one plate used in conjunction with a steel strap or shape in a timber-to-metal joint) used with a bolt, two washers and a nut.

MULTIPLE SHEAR-PLATE LOADS

For a joint assembly in which more than one shear-plate unit is used with specified bolt and washer sizes, the total safe load capacity of the connectors is equal to the sum of the loads for all the units.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on shear-plates may be taken as 116% the Standard Design Loads parallel to the grain and as 130% of the Standard Design Loads perpendicular to grain with loads at intermediate angles to grain obtained by interpolation, provided the resulting size or number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a shear-plate due to a force producing impact shall be taken as 115% of the sum of the force as a static load and the load due to its impact.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 10. Loads for end and edge distances and spacings intermediate of standard and minimum may be determined by interpolation.

LOAD AT ANGLE TO GRAIN

Loads at angles to grain intermediate of those in the table may be determined by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average total deformations in inches for shear-plate joints from zero load to Standard Design Loads are as follows:

Shear-Plate Number	Plate Diameter inches	Bolt Diameter inches	Load Applied: Parallel to grain inches	Load Applied: Perpendicular to grain inches
1	2-5/8	3/4	.073	.100
2	4	3/4	.098	.102
2-A	4	7/8	.050	.090

STANDARD DESIGN LOADS FOR ONE SHEAR-PLATE UNIT AND BOLT IN SINGLE SHEAR

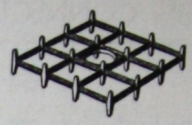
Species	SHEAR-PLATE Number	SHEAR-PLATE diameter (inches)	BOLT diameter (inches)	Lumber thickness (net) for Connectors used: In one face only	Lumber thickness (net) for Connectors used: Opposite in two faces	Allowable LOAD in pounds per CONNECTOR UNIT and BOLT at angle of load to grain of: 0°	15°	30°	45°	60°	75°	90°
GROUP A Dense structural grades of **Douglas Fir, Southern Pine**	1	2 5/8	3/4	1" and thicker	1-5/8"	2880	2760	2640	2520	2400	2280	2160
					2" and thicker	3450	3307	3163	3020	2877	2733	2590
	2	4	3/4	1-5/8" and thicker	1-3/4"	4250	4003	3757	3510	3263	3017	2770
					2"	4600	4333	4067	3800	3533	3267	3000
					2-5/8"	5080	5080	4853	4535	4217	3898	3580
					3"	5080	5080	5080	4975	4627	4278	3930
					3-5/8" and thicker	5080	5080	5080	5080	4897	4528	4160
	2-A	4	7/8	1-5/8" and thicker	1-3/4"	4250	4003	3757	3510	3263	3017	2770
					2"	4600	4333	4067	3800	3533	3267	3000
					2-5/8"	5490	5172	4853	4535	4217	3898	3580
					3"	6020	5672	5323	4975	4627	4278	3930
					3-5/8" and thicker	6370	6002	5633	5265	4897	4528	4160
GROUP B Non-dense structural grades of **Douglas Fir, Southern Pine;** structural grades of **Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak**	1	2 5/8	3/4	1" and thicker	1-5/8"	2500	2397	2293	2190	2087	1983	1880
					2" and thicker	3000	2875	2750	2625	2500	2375	2250
	2	4	3/4	1-5/8" and thicker	1-3/4"	3700	3485	3270	3055	2840	2625	2410
					2"	4000	3768	3537	3305	3074	2842	2610
					2-5/8"	4760	4487	4213	3940	3667	3393	3120
					3"	5080	4920	4620	4320	4020	3720	3420
					3-5/8" and thicker	5080	5080	4887	4570	4253	3937	3620
	2-A	4	7/8	1-5/8" and thicker	1-3/4"	3700	3485	3270	3055	2840	2625	2410
					2"	4000	3768	3537	3305	3074	2842	2610
					2-5/8"	4760	4487	4213	3940	3667	3393	3120
					3"	5220	4920	4620	4320	4020	3720	3420
					3-5/8" and thicker	5520	5203	4887	4570	4253	3937	3620
GROUP C Structural grades of **Cypress, Redwood**	1	2 5/8	3/4	1" and thicker	1-5/8"	2130	2042	1953	1865	1777	1688	1600
					2" and thicker	2550	2443	2337	2230	2123	2017	1910
	2	4	3/4	1-5/8" and thicker	1-3/4"	3140	2958	2777	2595	2413	2232	2050
					2"	3400	3203	3007	2810	2613	2417	2220
					2-5/8"	4050	3817	3583	3350	3117	2883	2650
					3"	4450	4193	3937	3680	3423	3167	2910
					3-5/8" and thicker	4710	4438	4167	3895	3623	3352	3080
	2-A	4	7/8	1-5/8" and thicker	1-3/4"	3140	2958	2777	2595	2413	2232	2050
					2"	3400	3203	3007	2810	2613	2417	2220
					2-5/8"	4050	3817	3583	3350	3117	2883	2650
					3"	4450	4193	3937	3680	3423	3167	2910
					3-5/8" and thicker	4710	4438	4167	3895	3623	3352	3080

Basic values for shear-plates, from which Standard Design Loads for the different thicknesses of lumber were derived, for Group B species parallel to the grain are 2610 lbs., 4420* lbs. and 4800 lbs. and perpendicular to the grain are 1955 lbs., 3150 lbs. and 3150 lbs. for the Nos. 1, 2 and 2A shear-plates respectively. Values for Group A species are 15 per cent greater and values for Group C species are 15 per cent less than for Group B species. For wind loads, basic values may be increased 33 per cent.

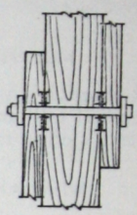
***While tests indicated a higher value parallel to grain for the joint assembly, the allowable shear for the 3/4 inch bolt (4420 lbs.) was assumed as the basic value in this instance. The type of failure in test indicated the 15 per cent increase applied to determine Standard Design Loads was justified.**

TIMBER CONNECTORS—SPIKE-GRID DESIGN DATA

SPIKE-GRID, Order Number	1	2	3
Type	Flat	Single Curve	Double Curve
(All dimensions in inches)			
Size, square	4-1/8	4-1/8	4-1/8
Total depth of grids, maximum	1	1.38	1.75
Length of spikes	.375	.375	.375
Width of fillets	.187	.187	.187
Maximum depth of fillets	.25	.63	1.00
Diameter of bolt hole	1.06	1.06	1.06
Shipping weight, per 100 grids, lbs.	50	75	107
LUMBER DIMENSIONS, minimum recommended for installation of flat grids			
Face width	5-1/2	5-1/2	.....
Thickness			
Grids one face only	1-5/8	1-5/8	.....
Grids opposite in both faces	2	.....	.....
Minimum diameter of pile for curved grids	.....	10	10
BOLT, diameter	3/4 or 1	3/4 or 1	3/4 or 1
BOLT HOLE, diameter in timber	13/16 or 1-1/16	13/16 or 1-1/16	13/16 or 1-1/16
WASHERS			
Round, cast or malleable iron	Standard Size for Bolt Diameter Used.		
Square plate	3x3x3/8 Punched for Bolt Diameter Used.		
SPACING OF GRIDS, minimum, center to center			
0°-30° angle of load to grain			
Spacing parallel to grain	7	7	7
Spacing perpendicular to grain	5-1/2	5-1/2	5-1/2
30°-90° angle of load to grain			
Spacing parallel or perpendicular to grain	5-1/2	5-1/2	5-1/2
END DISTANCES, center of grid to end of piece (tension or compression members)			
Standard	7	7	7
Minimum, reduce loads 15%	5	5	5
EDGE DISTANCES, center of grid to edge of piece			
Load applied at any angle to grain			
Standard	3-3/4	3-3/4	3-3/4
Minimum, reduce loads 15%	2-3/4	2-3/4	2-3/4
PROJECTED AREA for portion of one grid within member, square inches	2.06	2.06	2.06



FLAT SPIKE-GRID



FLAT SPIKE-GRID JOINT

Spike-grids opposite in both faces of middle member; in one face of side members

(Two braces attached to timber)

SPIKE-GRID SPECIFICATIONS

Spike-grid timber connectors shall be manufactured according to A.S.T.M. Standard Specifications A 47-33, Grade 35018, for malleable iron castings. They shall consist of four rows of opposing spikes forming a 4-1/8" square grid with 16 teeth which are held in place by fillets. Fillets for the flat grid in cross section shall be diamond shaped. Fillets for the single and double curve grids shall be increased in depth to allow for curvature and shall maintain a thickness between the sloping faces of the fillets equal to the width of the fillet. Spike-grids shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to spike-grids used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of its surface. Loads for spike-grids in green lumber (24 per cent or more moisture content) should not exceed 60 per cent of those shown; for intermediate moisture contents between 24 per cent and 15 per cent, interpolate according to the percentage of moisture content of the timber surface.

TIMBER CONNECTORS—SPIKE-GRIDS—SAFE LOADS

SINGLE SPIKE-GRID LOADS

The loads given are for a two member joint assembly with one spike-grid a bolt, two washers and a nut.

MULTIPLE SPIKE-GRID LOADS

For a joint assembly in which more than one spike-grid of the same or of different types are used in the contact faces of the timbers the total safe load on the connectors is the sum of the loads given for each grid used.

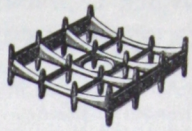
WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on spike-grids may be taken as 130% of the Standard Design Loads provided the resulting size and number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a spike-grid due to a force producing impact shall be taken as 115% of the sum of the force as a static load and the load due to its impact.

LOADS IN RELATION TO DISTANCES AND SPACINGS



SINGLE CURVE SPIKE-GRID

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 12. Loads for end and edge distances and spacings intermediate of standard and minimum may be determined by interpolation.

LOAD AT ANGLE TO GRAIN

Loads at angles to grain intermediate of those in the table may be determined by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average total deformations in inches for spike-grid joints from zero load to Standard Design Loads are as follows:

Spike Grid Number	Bolt Diameter inches	Load Applied Parallel to grain inches	Load Applied Perpendicular to grain inches
1	3/4	.012	.013
	1	.015	.021
2	3/4	.011	.020
	1	.018	.025
3	3/4	.011†	.020†
	1	.018†	.025†

†Estimated

STANDARD DESIGN LOADS* FOR ONE SPIKE-GRID AND BOLT IN SINGLE SHEAR

Species	SPIKE-GRID Number	SPIKE-GRID Size (inches)	BOLT diameter (inches)	Lumber thickness (net) and 10″ minimum pile diameter for Connectors used: In one face only	Lumber thickness (net) and 10″ minimum pile diameter for Connectors used: Opposite in two faces	Allowable LOAD in pounds per CONNECTOR and BOLT at angle of load to grain of: 0°	45°	90°
GROUP A Dense structural grades of **Douglas Fir, Southern Pine**	1, 2 and 3	4 1/8 × 4 1/8	3/4		2″	3320	3000	2670
				1-5/8″ and thicker	2-5/8″ and thicker	4100	3700	3300
			1		2″	3650	3285	2920
				1-5/8″ and thicker	2-5/8″ and thicker	4500	4050	3600
GROUP B Non-dense structural grades of **Douglas Fir, Southern Pine;** structural grades of **Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak**	1, 2 and 3	4 1/8 × 4 1/8	3/4		2″	3160	2845	2430
				1-5/8″ and thicker	2-5/8″ and thicker	3900	3450	3000
			1		2″	3440	3035	2630
				1-5/8″ and thicker	2-5/8″ and thicker	4250	3750	3250
GROUP C Structural grades of **Cypress, Redwood**	1, 2 and 3	4 1/8 × 4 1/8	3/4		2″	2530	2100	1670
				1-5/8″ and thicker	2-5/8″ and thicker	3120	2590	2060
			1		2″	2610	2170	1730
				1-5/8″ and thicker	2-5/8″ and thicker	3230	2680	2130

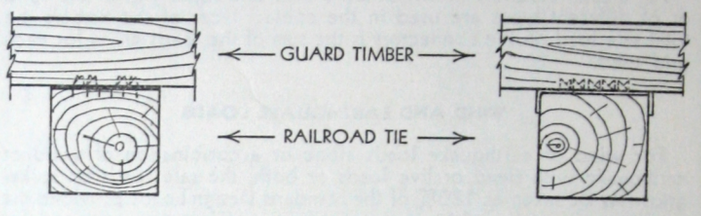
***Load values in the table are a conservative interpretation of a limited number of tests with a factor of safety of 4 on maximum test loads. Further investigation will probably show an increase for these values.**

TIMBER CONNECTORS—CLAMPING-PLATES

CLAMPING-PLATES, Order Number	1	2
Type	Plain	Flanged
(All dimensions in inches)		
Length of plate	5-1/4	8
Width of plate	5-1/4	5
Thickness of metal	.077	.122
Depth of flange	.....	2
Number of teeth on each face	12	.....
Number of teeth on top face	.....	14
Length of teeth	.68	.72
Diameter of bolt hole	1.12	1.12
Shipping weight per 100 pieces, lbs.	65	200
LUMBER DIMENSIONS, minimum required for installation of plates		
Face width	6-1/2	6-1/2
Thickness, plates in one face only	1-5/8	2-5/8
Thickness, plates opposite on both faces	2-5/8	5-1/2
BOLT diameter, minimum	3/4	3/4
BOLT HOLE, diameter in timber	13/16	13/16
WASHERS		
Round, cast or malleable iron, diameter	3	3
Square plate:		
Length of side	3	3
Thickness	1/4	1/4
SPACING OF CLAMPING-PLATES		
Minimum center-to-center		
Parallel to grain	6	8-1/2
Perpendicular to grain	6	5-1/2
END DISTANCES		
Center of plate to end of piece		
Plain type	5	.....
Flanged type:		
Toothed side	.....	5
Flanged side	.....	2-1/2
EDGE DISTANCES		
Center of plate to edge of piece		
Plain type	3-1/4	.....
Flanged type:		
Toothed side	.....	3-1/4
Flanged side	.....	4

PLAIN CLAMPING-PLATE

FLANGED CLAMPING-PLATE



CLAMPING-PLATES USED BETWEEN RAILROAD TIES AND GUARD TIMBERS

Plates may be used with a bolt through each joint or at every third or fourth joint.

DEFORMATION OF JOINTS UNDER LOAD

The average deformations in inches for clamping-plate joints from zero load to Standard Design Loads are as follows:

Clamping-Plate Number	Type of Connection	Load Applied Parallel to grain, inches	Load Applied Perpendicular to grain, inches
1	3/4" Bolt	...	.013
1	No Bolt	...	.013
2	Teeth Only	.019	...
2	Flange Only	...	.025

CLAMPING-PLATE SPECIFICATIONS

Clamping-plate timber connectors shall be stamped cold from mild steel conforming to A.S.T.M. Standard Specifications for carbon steel A 17-29, Type A, Grade 1.

Plain Clamping-Plate—Plain clamping-plates shall consist of a square steel plate with a central bolt hole and twelve teeth projecting from each face. The flat sides of the teeth on each face shall be parallel to each other and arranged with the flat sides of the teeth on opposite faces of the plate at right angles to each other. Clamping-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

Flanged Clamping-Plate—Flanged clamping-plates shall consist of a rectangular steel plate with a central bolt hole around which fourteen teeth shall project from one face with their flat sides parallel to the long edges of the plate. The metal near the two narrow ends of the plate shall be bent at right angles to the plate and in a direction opposite to the teeth to form flanges. Flanged clamping-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

SINGLE CLAMPING-PLATE LOADS

The loads given are for a two member joint assembly with one plain or flanged clamping-plate either with or without a bolt through the joint as specified in the tables.

MULTIPLE CLAMPING-PLATE LOADS

For a joint assembly in which more than one clamping-plate is used, the total safe connector load is equal to the sum of the loads specified for the individual plates with or without bolts used in the joint.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on clamping-plates may be taken as 116 per cent of the Standard Design Loads provided the resulting number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a clamping-plate due to a force producing impact shall be taken as 115 per cent of the sum of the force as a static load and the load due to its impact.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Spacings of plates and end and edge distances less than the minimums specified are not recommended.

CONDITION OF LUMBER

Tabulated loads apply to the plain clamping-plate (where the teeth rather than the flange determine the load capacity) used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface. Loads for the plain clamping-plates in green lumber (24 per cent or more moisture content) should not exceed 60 per cent of those shown; for intermediate moisture contents between 24 per cent and 15 per cent, interpolate according to the percentage of moisture content of the timber surface. Tabulated loads apply to the flanged clamping-plate in either seasoned or green lumber.

STANDARD DESIGN LOADS PER CLAMPING-PLATE

Species	CLAMPING-PLATE Number	CLAMPING-PLATE Size (inches)	Type of Joint Connection	Angle of Load to grain 90°
GROUP A Dense structural grades of **Douglas Fir, Southern Pine**	1	5¼×5¼	3/4" Through Bolt	3,400
			No Through Bolt*	2,460
	2	5 × 8	Teeth Only (No Through Bolt)	2,920
			One Flange Only (No Through Bolt)	1,610
GROUP B Non-dense structural grades of **Douglas Fir, Southern Pine;** structural grades of **Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak**	1	5¼×5¼	3/4" Through Bolt	3,080
			No Through Bolt	2,230
	2	5 × 8	Teeth Only (No Through Bolt)	2,660
			One Flange Only (No Through Bolt)	1,610
GROUP C Structural grades of **Cypress, Redwood**	1	5¼×5¼	3/4" Through Bolt	2,770
			No Through Bolt	2,010
	2	5 × 8	Teeth Only (No Through Bolt)	2,390
			One Flange Only (No Through Bolt)	1,610

*Joint members held in contact by bolts outside joint area.

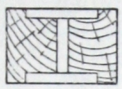
Basic values for clamping-plates, from which Standard Design Loads were derived for Group B species for timbers overlapping at right angles (90°) to the grain, are 2680 lbs. and 1940 lbs. for the plain clamping-plate with a 3/4" through bolt and with no through bolt respectively; and 2310 lbs. and 1400 lbs. for the flanged plate with teeth only and one flange only respectively. With the exception of the value for the flange only of the flanged-plate where the bending of the flange results in ultimate failure, values for Group A species are 10 per cent greater and for Group C species are 10 per cent less than those for Group B species. For wind loads basic values may be increased 33-1/3 per cent.

TIMBER CONNECTORS—NET SECTION OF TIMBERS—GALVANIZING SPECIFICATION

NET SECTION

The net section of a timber in a connector joint is usually adequate to transmit the full strength of the timber which can be developed outside of the joint when the lower grades of lumber are used. However, it may be desirable to check the strength of the net section of timbers when they are of the minimum size recommended herein for a given connector, particularly if a high stress-grade of lumber is used.

The critical or "net" section of a timber in a joint, which will generally pass through the center line of a bolt and connector, occurs at the plane of maximum stress. The net cross section at this plane is equal to the full cross-sectional area of the timber minus the projected area of that portion of the connectors within the member and that portion of the bolts, not within the connector projected area, located at this plane.



Shaded Area Shows Net Cross Section of Timber

Due to wood being able to support loads of short-time duration greatly in excess of permanently applied loads, computation of the required net section in tension or compression involves consideration of the different types and amounts of loadings. Constants in the table for Standard loading apply for the same loading conditions as described on page 3 for Standard Design Loads for connectors. Constants for wind or earthquake loads apply to wind and earthquake loads alone or when combined with live or dead loads or both; in which cases however the resulting net section shall not be less than required for dead and live loads alone. Constants for impact apply to that portion of impact which exceeds 100 per cent of the load producing the impact. Constants for dead load apply where the full design load is permanently applied.

The net cross sectional area in square inches required at the critical section may be determined by multiplying the total load in pounds, which is transferred through the critical section of the member, by the appropriate constant given in the table. Conversely, the total working load capacity in pounds of a given net area may be determined by dividing the net area in square inches by the appropriate constant.

***CONSTANTS FOR USE IN DETERMINING REQUIRED NET SECTION IN SQUARE INCHES**

Type of Loading	Thickness of Wood Member in Inches	CONSTANTS FOR EACH CONNECTOR LOAD GROUP		
		Group A	Group B	Group C
Standard	4″ or less	.00041	.00046	.00048
	over 4″	.00051	.00058	.00060
Wind or Earthquake	4″ or less	.00031	.00036	.00037
	over 4″	.00039	.00044	.00046
Impact	4″ or less	.00023	.00027	.00028
	over 4″	.00029	.00033	.00035
Dead Load	4″ or less	.00047	.00053	.00055
	over 4″	.00058	.00067	.00069

*** The above constants, computed from basic recommendations of the Forest Products Laboratory, are based on a permissible tensile stress at the net section equal to the basic stress for clear wood in compression parallel to grain increased 25 per cent for the greater strength of dry material 4″ and less in thickness and adjusted for the duration-of-loading effect by an increase of 15 per cent for standard loading, 50 per cent for wind or earthquake loading, and 100 per cent for impact loading.**

The above recommendations assume the condition usually encountered, that a knot approaching the maximum size allowed for the grade will not occur at, or within one-half the connector diameter of, the plane of the critical section. When it is anticipated that knots approaching the maximum size may be present at or near the critical plane the critical section area must be further reduced by the projected area of the knot, excluding from the reduction any portion of the knot which is within the projected area of the connector or bolt.

For the clamping-plates, net section is generally not a factor in determining the size of the timbers in which they are used but it may be computed by subtracting the projected area of the bolt diameter only from the cross section, since the teeth of the plate, embedded with their flat sides parallel to the grain, cut only a small percentage of the wood fibers.

SPECIFICATION WHEN GALVANIZING IS REQUIRED

The Galvanizing specifications for all types of timber connectors shall conform to A.S.T.M. Standard Specifications for Galvanizing.

1. Zinc used in the bath shall be at least equal to "Prime Western."

2. The weight of the zinc coating per square foot of actual surface shall average not less than 2.0 oz. and no individual specimen shall show less than 1.8 oz., weight to be determined by stripping an entire piece by A.S.T.M. Standard Method A 90-33.

3. The zinc coating shall be adherent, smooth, continuous and thorough, except that uncoated spots on the tongue and groove surfaces in contact will not be cause for rejection. It shall be free from imperfections such as bumps, blisters, gritty areas, uncoated spots, acid and black spots, dross and flux.

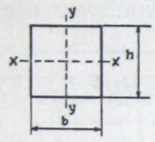
4. When visual inspection and testing with 1/2 lb. hammer is not conclusive, tests shall be made by the Preece method, in which case the minimum thickness of coating shall withstand at least seven 1-minute dips.

5. Test samples may be selected from deliveries at random and will be tested by the purchaser and at purchaser's expense.

PROJECTED AREA OF CONNECTORS AND BOLTS
(For Use in Determining Net Sections)

Connector No.	Connector Size	Bolt Diam. (inches)	Placement of Connectors	Total Projected Area in Square Inches of Connectors and Bolts in Lumber Thickness of									
				1-5/8″	2″	2-5/8″	3″	3-5/8″	4″	5-1/2″	6″	7-1/2″	8″
SPLIT-RINGS													
1	2-1/2	1/2	One Face	1.73	1.92	2.23	2.42	2.73	2.92	3.67	3.92	4.67	4.92
		1/2	Two Faces	2.64	2.83	3.14	3.34	3.64	3.83	4.58	4.83	5.58	5.83
2	4	3/4	One Face	3.09	3.37	3.84	4.12	4.59	4.87	6.00	6.37	7.50	7.87
		3/4	Two Faces	4.97	5.25	5.72	6.00	6.47	6.75	7.16	8.25	9.38	9.75
3	6	3/4	One Face	4.91	5.19	5.66	5.94	6.41	6.69	7.10	8.19	9.32	9.69
		3/4	Two Faces	.....	8.88	9.35	9.63	10.10	10.38	10.79	11.88	13.01	13.38
TOOTHED-RINGS													
1	2	/2	One Face	1.52	1.71	2.02	2.21	2.52	2.71	3.46	3.71	4.46	4.71
		1/2	Two Faces	2.22	2.41	2.72	2.91	3.22	3.41	4.16	4.41	5.16	5.41
2	2-5/8	5/8	One Face	1.95	2.18	2.58	2.81	3.20	3.44	4.37	4.69	5.62	5.94
		5/8	Two Faces	2.89	3.12	3.52	3.75	4.14	4.38	5.31	5.63	6.56	6.88
3	3-3/8	3/4	One Face	2.46	2.74	3.21	3.49	3.96	4.24	5.37	5.74	6.87	7.24
		3/4	Two Faces	3.70	3.98	4.45	4.73	5.20	5.48	6.61	6.98	8.11	8.48
4	4	3/4	One Face	2.75	3.03	3.50	3.78	4.25	4.53	5.66	6.03	7.16	7.53
		3/4	Two Faces	4.28	4.56	5.03	5.31	5.78	6.06	7.19	7.56	8.69	9.06
CLAW-PLATES													
1 and 1A	2-5/8	1/2	One Face	2.41	2.60	2.91	3.10	3.41	3.60	4.35	4.60	5.53	5.60
		1/2	Two Faces	.....	4.19	4.50	4.69	5.00	5.19	5.94	6.19	6.94	7.19
2 and 2A	3-1/8	1/2	One Face	2.78	2.97	3.28	3.47	3.78	3.97	4.72	4.97	5.72	5.97
		1/2	Two Faces	.....	4.93	5.24	5.43	5.74	5.93	6.68	6.93	7.68	7.93
3 and 3A	4	3/4	One Face	3.66	3.94	4.41	4.69	5.16	5.44	6.57	6.94	8.07	8.44
		3/4	Two Faces	.....	6.37	6.84	7.12	7.59	7.87	9.00	9.37	10.50	10.87
SHEAR-PLATES													
1	2-5/8	3/4	One Face	1.92	2.20	2.67	2.95	3.42	3.70	4.83	5.20	6.33	6.70
		3/4	Two Faces	2.62	2.90	3.37	3.65	4.12	4.40	5.53	5.90	7.03	7.40
2	4	3/4	One Face	3.23	3.51	3.98	4.26	4.73	5.01	6.14	6.51	7.64	8.01
		3/4	Two Faces	.....	5.52	5.99	6.27	6.74	7.02	8.15	8.52	9.65	10.02
2-A	4	7/8	One Face	3.36	3.69	4.24	4.56	5.11	5.44	6.75	7.19	8.50	8.94
		7/8	Two Faces	.....	5.62	6.17	6.49	7.04	7.37	8.68	8.12	10.43	10.87
SPIKE-GRIDS													
1, 2 and 3	4-1/8 x 4-1/8	3/4	One Face	2.90	3.18	3.65	3.93	4.40	4.68	5.81	6.18	7.31	7.68
		3/4	Two Faces	.....	4.87	5.34	5.62	6.09	6.37	7.50	7.87	9.00	9.37
		1	One Face	3.18	3.56	4.18	4.56	5.18	5.56	7.06	7.56	9.06	9.56
		1	Two Faces	.....	5.13	5.75	6.13	6.75	7.13	8.63	9.13	10.63	11.13

PROPERTIES OF LUMBER SIZES—LEGEND



DIMENSIONAL PROPERTIES OF AMERICAN STANDARD SIZES OF YARD LUMBER AND TIMBERS

NOMINAL SIZE b Inches h	AMERICAN STANDARD DRESSED SIZE (S4S) b Inches h	AREA OF SECTION (Sq. In.) A=b×h	MOMENT OF INERTIA		SECTION MODULUS	
			I x–x = bh³/12	I y–y = b³h/12	S x–x = bh²/6	S y–y = b²h/6
2 x 4	1-5/8 x 3-5/8	5.89	6.45	1.30	3.56	1.60
2 x 6	1-5/8 x 5-5/8	9.14	24.10	2.01	8.57	2.48
2 x 8	1-5/8 x 7-1/2	12.19	57.13	2.68	15.23	3.30
2 x 10	1-5/8 x 9-1/2	15.44	116.10	3.40	24.44	4.18
2 x 12	1-5/8 x 11-1/2	18.69	205.95	4.11	35.82	5.06
2 x 14	1-5/8 x 13-1/2	21.94	333.18	4.83	49.36	5.94
2 x 16	1-5/8 x 15-1/2	25.19	504.27	5.54	65.07	6.82
2 x 18	1-5/8 x 17-1/2	28.44	725.75	6.25	82.94	7.70
3 x 4	2-5/8 x 3-5/8	9.52	10.42	5.46	5.75	4.16
3 x 6	2-5/8 x 5-5/8	14.77	38.93	8.48	13.84	6.46
3 x 8	2-5/8 x 7-1/2	19.69	92.29	11.30	24.61	8.61
3 x 10	2-5/8 x 9-1/2	24.94	187.55	14.32	39.48	10.91
3 x 12	2-5/8 x 11-1/2	30.19	332.69	17.33	57.86	13.21
3 x 14	2-5/8 x 13-1/2	35.44	538.21	20.35	79.73	15.50
3 x 16	2-5/8 x 15-1/2	40.69	814.60	23.36	105.11	17.80
3 x 18	2-5/8 x 17-1/2	45.94	1172.36	26.38	133.98	20.10
4 x 4	3-5/8 x 3-5/8	13.14	14.39	14.39	7.94	7.94
4 x 6	3-5/8 x 5-5/8	20.39	53.76	22.33	19.12	12.32
4 x 8	3-5/8 x 7-1/2	27.19	127.44	29.77	33.98	16.43
4 x 10	3-5/8 x 9-1/2	34.44	259.00	37.71	54.53	20.81
4 x 12	3-5/8 x 11-1/2	41.69	459.43	45.65	79.90	25.19
4 x 14	3-5/8 x 13-1/2	48.94	743.24	53.59	110.11	29.57
4 x 16	3-5/8 x 15-1/2	56.19	1124.92	61.53	145.15	33.95
4 x 18	3-5/8 x 17-1/2	63.44	1618.98	69.47	185.03	38.33
6 x 6	5-1/2 x 5-1/2	30.25	76.26	76.26	27.73	27.73
6 x 8	5-1/2 x 7-1/2	41.25	193.36	103.98	51.56	37.81
6 x 10	5-1/2 x 9-1/2	52.25	392.96	131.71	82.73	47.90
6 x 12	5-1/2 x 11-1/2	63.25	697.07	159.44	121.23	57.98
6 x 14	5-1/2 x 13-1/2	74.25	1127.67	187.17	167.06	68.06
6 x 16	5-1/2 x 15-1/2	85.25	1706.78	214.90	220.23	78.15
6 x 18	5-1/2 x 17-1/2	96.25	2456.38	242.63	280.73	88.23
8 x 8	7-1/2 x 7-1/2	56.25	263.67	263.67	70.31	70.31
8 x 10	7-1/2 x 9-1/2	71.25	535.86	333.98	112.81	89.06
8 x 12	7-1/2 x 11-1/2	86.25	950.55	404.30	165.31	107.81
8 x 14	7-1/2 x 13-1/2	101.25	1537.73	474.61	227.81	126.56
8 x 16	7-1/2 x 15-1/2	116.25	2327.42	544.92	300.31	145.31
8 x 18	7-1/2 x 17-1/2	131.25	3349.61	615.23	382.81	164.06
10 x 10	9-1/2 x 9-1/2	90.25	678.76	678.76	142.90	142.90
10 x 12	9-1/2 x 11-1/2	109.25	1204.03	821.65	209.40	172.98
10 x 14	9-1/2 x 13-1/2	128.25	1947.80	964.55	288.56	203.06
10 x 16	9-1/2 x 15-1/2	147.25	2948.07	1107.44	380.40	233.15
10 x 18	9-1/2 x 17-1/2	166.25	4242.84	1250.34	484.90	263.23
12 x 12	11-1/2 x 11-1/2	132.25	1457.51	1457.51	253.48	253.48
12 x 14	11-1/2 x 13-1/2	155.25	2357.86	1710.98	349.31	297.56
12 x 16	11-1/2 x 15-1/2	178.25	3568.71	1964.46	460.48	341.65
12 x 18	11-1/2 x 17-1/2	201.25	5136.07	2217.94	586.98	385.73
14 x 14	13-1/2 x 13-1/2	182.25	2767.92	2767.92	410.06	410.06
14 x 16	13-1/2 x 15-1/2	209.25	4189.36	3177.98	540.56	470.81
14 x 18	13-1/2 x 17-1/2	236.25	6029.30	3588.05	689.06	531.56
14 x 20	13-1/2 x 19-1/2	263.25	8341.73	3998.11	855.56	592.31

LINEAR CONVERSION TABLE

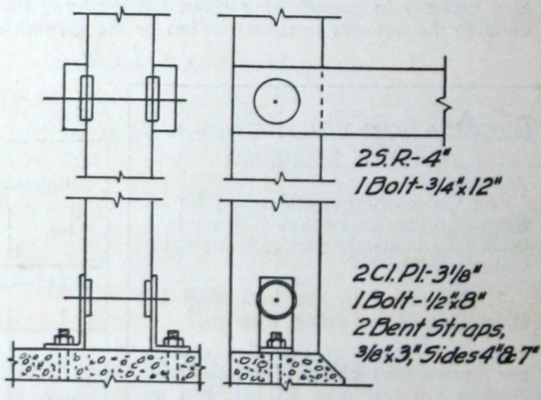
Fraction of Inch	Decimal of Inch	Decimal of Foot	Inches	Decimal of Foot
1/16	0.0625	0.0052	1	0.0833
1/8	.1250	.0104	2	.1667
3/16	.1875	.0156	3	.2500
1/4	.2500	.0208	4	.3333
5/16	0.3125	0.0260	5	0.4167
3/8	.3750	.0313	6	.5000
7/16	.4375	.0365	7	.5833
1/2	.5000	.0417	8	.6667
9/16	0.5625	0.0469	9	0.7500
5/8	.6250	.0521	10	.8333
11/16	.6875	.0573	11	.9167
3/4	.7500	.0625	12	1.0000
13/16	0.8125	0.0677		
7/8	.8750	.0729		
15/16	.9375	.0781		
1	1.0000	.0833		

LEGEND FOR TIMBER CONNECTORS, GROOVES AND DAPS

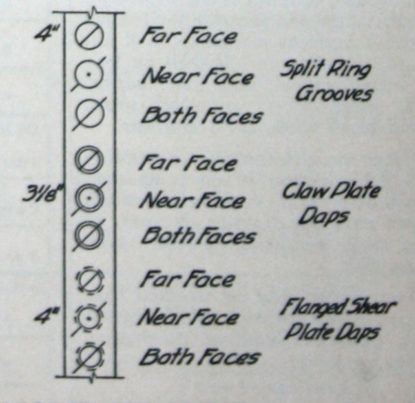
The sample legends shown below indicate the sizes and positions of connectors on structural drawings and shop details.

All types of circular connectors may be indicated on structural drawings by a circle with the type, size and number of connectors and bolts written in near the joint. Where two types of connectors occur in the same design, a double circle for indicating one type and a single circle for the other type will make it easier to determine rapidly the location of each type of connector. The square grids and clamping plates may be shown by a square drawn around the bolt hole; the number of connectors and type, also the bolt size should be written in on the drawing.

Grooves or daps for connectors on shop drawings may likewise be indicated by a circle provided only one kind is used on a drawing. If grooves and daps must both be shown, a single and double lined circle will be sufficient to differentiate them. Where three types of grooves must be cut, a solid circle within a dashed circle may be used to indicate the third type. The diameter of the groove or dap must be written on the drawing to avoid confusion unless all are the same diameter. The occurrence of the groove or dap on the near, far or both faces may be indicated by a diagonal line as shown on the accompanying sketch.



DETAILS



LEGEND FOR GROOVES AND DAPS
(Shop Details)

Printed in U. S. A. 10-39-30M——12-40-30M